A nail forming device forms a drawing pattern on the surface of a nail (or an artificial nail) by using a photo-curable resin. The nail forming device includes a light source, an optical drawing unit for partially curing the photo-curable resin by using light emitted by the light source, and a controller for controlling the light source and the optical drawing unit. According to the nail forming device, a drawing pattern may be easily formed.
FIG. 5

1. Resin-Coating Step S1

3a, 3b. Removal Step S3

(CURING STEP S2)

(SELECT DRAWING PATTERN)

(RESIN CURING)
NAIL MOLDING DEVICE AND NAIL MOLDING METHOD

TECHNICAL FIELD

[0001] The present invention relates to a nail forming device and a nail forming method for drawing on nails or artificial nails. Conventional nail art involves a user having a desired design drawn by a nail technician at a nail salon. As a result, the material of the nail, gel nail, is widely used. While the widespread use of gel nails consume the nail art are on the increase.

BACKGROUND ART

[0002] With a nail art of drawing on the surface of a nail, a user generally has a desired design drawn by a nail technician at a nail salon. As the material of the nail, the gel nail made of a photo-curable resin is widely used. With the widespread use of gel nails, the nail art are on the increase.

[0003] In recent years, due to the facility of the gel nails, more and more users are applying the nail art themselves. As a product for supporting application of the nail art by users themselves, a starter kit, which is a set of gels and a resin curing lamp, is being sold.

[0004] For example, Patent Literature 1 and 2 disclose methods for having a resin-coated finger (nail) inserted into an opening portion of a resin curing lamp, and for radiating the entire finger inserted in the opening portion by the resin curing lamp. Patent Literature 3 discloses a configuration of a pen-type resin curing lamp with a small light radiation area, which takes into account the influence of UV light for resin curing on the human body. Patent Literature 4 discloses a configuration which includes a two-wavelength light source to be used according to the type of a photo-curable resin.

CITATION LIST

Patent Literature

[0005] PTL 1: Utility Model Registration No. 3151698
[0006] PTL 2: Utility Model Registration No. 3183499
[0007] PTL 3: Utility Model Registration No. 3179777

SUMMARY OF THE INVENTION

[0009] A nail forming device according to a mode of the present invention is a nail forming device for forming a drawing pattern on a surface of a nail or an artificial nail by using a photo-curable resin, the device including a light source, an optical drawing unit for partially curing the photo-curable resin by using light emitted from the light source, and a controller for controlling the light source and the optical drawing unit.

[0010] Also, a nail forming method according to a mode of the present invention is a nail forming method for forming a drawing pattern on a surface of a nail or an artificial nail by using a photo-curable resin. There are included coating the surface of the nail or the artificial nail with the photo-curable resin, partially curing the photo-curable resin, and removing a non-cured part of the photo-curable resin. Also, in the curing, the photo-curable resin is partially cured by using a nail forming device including a light source, an optical drawing unit for partially curing the photo-curable resin by using light emitted from the light source, and a controller for controlling the light source and the optical drawing unit.

[0011] According to the configurations described above, a drawing pattern may be easily formed on the surface of a nail or an artificial nail.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 is a schematic diagram showing a nail forming device according to an exemplary embodiment of the present invention.
[0013] FIG. 2 is a perspective diagram of a reflection mirror configuring the nail forming device according to the exemplary embodiment of the present invention.
[0014] FIG. 3 is a diagram showing drawing patterns.
[0015] FIG. 4 is a schematic diagram showing a light radiation state of the nail forming device according to the exemplary embodiment of the present invention.
[0016] FIG. 5 is a schematic diagram showing a nail forming method that uses the nail forming device according to the exemplary embodiment of the present invention.

DESCRIPTION OF EMBODIMENT

[0017] Before describing an exemplary embodiment, a problem inherent in a conventional nail art will be described.

[0018] Conventionally, the drawing skill of a user greatly affects the drawing of a nail art by the user himself/herself. Even, even if the drawing skill is high, in the case of drawing on the nails of the user himself/herself, it is difficult to achieve the same drawing accuracy for the nails of the dominant hand and the nails of the hand which is not the dominant hand.

[0019] Moreover, even in the case where a nail technician in a nail salon is to perform drawing, there is a limit on the drawing skill. However, higher accuracy is demanded for drawing.

EXEMPLARY EMBODIMENT

[0020] In the following, an exemplary embodiment of the present invention will be described with reference to FIGS. 1 to 5.
[0021] FIG. 1 is a schematic diagram showing nail forming device 2 for drawing a nail art (for forming a drawing pattern) on nail 1. Nail forming device 2 is a nail forming device 2 for forming a drawing pattern on the surface of nail 1 (or an artificial nail) by using photo-curable resin 3, and includes light source 4, optical drawing unit 5 for partially curing photo-curable resin 3 by using light that is emitted from light source 4, and controller 6 for controlling light source 4 and optical drawing unit 5.

[0022] In the present exemplary embodiment, photo-curable resin 3 that is cured with UV light is used.

[0023] Light source 4 emits light of a wavelength by which photo-curable resin 3 is cured. Most of the gel nails (photo-curable resin 3) that are currently commercially available need wavelengths ranging from about 365 nm to 410 nm to be cured. Accordingly, in the present exemplary embodiment, a semiconductor laser having a wavelength peak around 405 nm is used as light source 4. Also, scanning reflection mirror 7 whose angle of reflection is controlled by controller 6 is used as optical drawing unit 5.

[0024] As scanning reflection mirror 7, a known mirror such as a polygon mirror or a galvanometer mirror is used.

[0025] Next, the configuration of reflection mirror 7 be described in detail with reference to FIG. 2.

[0026] FIG. 2 is a schematic diagram showing the reflection mirror configured with actuator 8 and mirror unit 9. Actuator 8 is driven in two axes, and is a MEMS (Micro Electro Mechanical Systems) device that uses
an Si substrate and a piezoelectric film. By configuring optical drawing unit 5 by actuator 8, nail forming device 2 may be miniaturized.

[0029] Actuator 8 includes rectangular support frame 9, rectangular movable frame 10 disposed on the inside of support frame 9, rectangular movable unit 11 disposed on the inside of movable frame 10, first vibration units 14, and second vibration units 16. Movable frame 10 is connected to support frame 9 by first vibration units 14. A pair of first vibration units 14 is to twist around first rotation axis 13. Movable unit 11 is connected to movable frame 10 by second vibration units 16. Second vibration units 16 are to twist around second rotation axis 15 that is orthogonal to first rotation axis 13. Additionally, first vibration units 14 are provided with first drive units 17. First drive units 17 are connected to controller 6. Twisting of drive unit 17 is controlled by a control signal from controller 6. Although not shown, first drive unit 17 has a laminate structure where a piezoelectric layer of PZT or the like is interposed between upper and lower electrodes made of Ti, Au or the like. By applying a potential difference between the upper and lower electrodes of first drive unit 17, twisting of first vibration unit 14 around first rotation axis 13 is excited.

[0030] Like first vibration unit 14, second vibration units 16 are provided with second drive units 18. Second drive units 18 are connected to controller 6. Twisting of second vibration unit 16 around second rotation axis 15 is excited by second drive unit 18.

[0031] Mirror unit 12 is disposed on the surface of movable unit 11 of actuator 8 configured in the above manner, and reflection mirror 7 may scan light emitted by light source 4 in the directions of two axes.

[0032] <Operation of Nail Forming Device 2>

[0033] Next, an operation of a nail forming device 2 will be described with reference to FIG. 1.

[0034] Controller 6 controls light source 4 and optical drawing unit 5. Controller 6 controls the amount of radiation and radiation time of light that is emitted by light source 4, the angle of reflection of mirror unit 12 provided to actuator 8, and the like. The surface of photo-curable resin 3 coating the surface of nail 1 is scanned by the light, and photo-curable resin 3 is partially cured. A drawing pattern is thus formed.

[0035] Additionally, as shown in FIG. 3, when forming a drawing pattern, if there is a density difference in the drawing pattern, pattern collapse is more likely to occur in an area where the drawing pattern is dense, compared to an area where the drawing pattern is rough. The cause of this pattern collapse is assumed to be blurring caused by diffusion of radiated light inside photo-curable resin 3. Accordingly, if same control is performed for when a dense drawing pattern is to be formed and when a rough drawing pattern is to be formed, the following problem will occur. If a drawing condition suitable for a dense drawing pattern is set, and a rough drawing pattern is formed, the rough drawing pattern is not desirably formed due to lack of exposure.

[0036] However, with nail forming device 2, which uses scanning reflection mirror 7 as described above, light source 4 and optical drawing unit 5 are controlled by controller 6, and photo-curable resin 3 may be partially cured. Unlike exposure with photomask, nail forming device 2 of the present exemplary embodiment may set a control condition for each section obtained by dividing a drawing area. Accordingly, even if there is a density difference in a drawing pattern, the control condition may be made different between a drawing area where a dense drawing pattern is to be formed and a drawing area where a rough drawing pattern is to be formed. That is, controller 6 may form an optimal drawing pattern by controlling light source 4 and optical drawing unit 5 according to the density of a drawing pattern. Formation of an optimal drawing pattern according to the density of a drawing pattern may be realized in the following manner.

[0037] The radiation time of light that is emitted by light source 4 on a drawing area on which a drawing pattern is to be formed is controlled by controller 6. The radiation tune is determined for each section of the divided drawing area.

[0038] Also, the level of output of light that is emitted by light source 4 on the drawing area on which a drawing pattern is to be formed is controlled by controller 6. The level of output of light is determined for each section of the drawing area.

[0039] Optimal control may be realized for each section obtained by division, by a combination of control conditions for the radiation tune of light and the level of output of light.

[0040] Also, in the case of performing control on a per section basis as described above, controller 6 has to perceive a drawing pattern. Thus, nail forming device 2 is desirably provided with communication unit 19 for obtaining a drawing pattern from outside. As communication unit 19, a wired communication unit such as an USB, or a wireless communication unit such as a wireless LAN or Bluetooth (registered trademark) may be used. Additionally, in the present exemplary embodiment, a wireless LAN is used as communication unit 19.

[0041] Moreover, with respect to a drawing pattern, a drawing pattern that is selected in advance by using a smartphone, a personal computer or the like is transferred to controller 6 by using a wireless LAN as communication unit 19. If a drawing pattern is input to nail forming device 2 from outside, the latest designs may be easily introduced even if designs are frequently updated. Accordingly, a drawing pattern may be selected from a large number of designs. Depending on the situation, users may link together and form a community.

[0042] <Details of Configuration of Nail Forming Device 2>

[0043] Nail forming device 2 desirably includes positioning unit 20 for determining the position of nail 1 on which drawing is to be performed. The present exemplary embodiment describes a guide for restricting the amount of insertion of a finger by causing the tip of nail 1 to come into contact with the guide, and for fixing the position of nail 1. The method described above is not restrictive as long as the position of nail 1 may be fixed. Providing positioning unit 20 allows the position of nail 1 to be fixed, and therefore allows application of a detailed drawing.

[0044] As shown in FIG. 4, the surface of nail 1 has a convex curved shape. Accordingly, the radiation distance from reflection mirror 7 is different for edge part 1a and center part 1b of nail 1. However, nail forming device 2 has a configuration where a semiconductor laser whose radiation light has high linearity is used as light source 4, and where light with high linearity is radiated on nail 1 via reflection mirror 7, and thus a variation in a beam spot diameter caused by a difference in the distance from light source is small, and deterioration of drawing accuracy on a curved surface is suppressed. Accordingly, highly detailed drawing is enabled.

[0045] Furthermore, angle of incidence 91 of light on tangent plane 1c of edge part 1a of curved nail 1 is smaller than angle of incidence 92 on tangent plane 1d of center part 10 of
the nail, and thus the radiation area of light is greater at edge part 1a than at center part 1b. Accordingly, the amount of received light per unit area is smaller at edge part 1a than at center part 1b. Therefore, light output to edge part 1a of nail 1 is desirably made greater than light output to center part 1b of nail 1. Besides using the method for performing adjustment based on the level of intensity of output light, adjustment may be performed by making the radiation time of light on edge part 1a longer than the radiation time of light on center part 1b of nail 1.

Additionally, adjustment of the radiation time may be controlled by adjusting the displacement rate of the angle of reflection mirror 7. However, it is difficult to finely adjust the angle of reflection. As a method for controlling the radiation time without controlling the angle of reflection, there is light emission control for the light source. The light control is of the number of times the light source is switched on during a period of scanning of a unit area by light. If a semiconductor laser is used, the number of times of switching on may be controlled by controlling a clock signal for performing light emission control of the semiconductor laser. If the semiconductor laser is used as the light source, the radiation time may be easily adjusted.

Moreover, a case where a semiconductor laser with high light linearly is used as light source 4 has been described above with respect to nail forming device 2, but a semiconductor light emitting element or a UV lamp whose radiation light is greatly diffused may alternatively be used as light source 4. In the case where the semiconductor light emitting element or the UV lamp is used, light linearity of radiation light may be obtained by interposing a collimator lens (not shown) between light source 4 and reflection mirror 7. If light linearity of radiation light may be obtained, the same effect as when a semiconductor laser is used may be achieved.

Furthermore, instead of using scanning reflection mirror 7 as described above as drawing means, a projection device such as a digital mirror device or a liquid crystal device may be used as drawing means.

Also, by providing storage unit 21 to controller 6, and storing typical drawing patterns in advance in storage unit 21, drawing may be performed based on stored drawing patterns. If controller 6 is provided with storage unit 21, a drawing pattern may be selected without using communication unit 19, and time may be reduced by the length of the transfer time for the drawing pattern.

Furthermore, to determine a control condition with respect to the curved shape of nail 1, nail forming device 2 further includes nail detector 22 for detecting the three-dimensional shape of nail 1, and controller 6 controls at least one of light source 4 and reflection mirror 7 according to first information detected by nail detector 22.

Feedback control is enabled by inputting information (first information) detected by nail detector 22 to controller 6 as appropriate. Accordingly, correction control for the angle of reflection of reflection mirror 7 and a radiation timing of light source 4 is enabled at nail forming device 2. Additionally, nail detector 22 may be a camera that uses images or may use various methods including an optical method that uses light reflection, for example. By performing feedback control by using nail detector 22, detailed drawing may be performed even if nail 1, which is a drawing target, moves.

Furthermore, nail forming device 2 further includes light source output measurement unit 23 for measuring the level of output of light that is emitted by light source 4, and controller 6 controls at least one of light source 4 and reflection mirror 7 according to second information that is measured by light source output measurement unit 23.

By performing feedback control by information (second information) measured by light source output measurement unit 23, nail forming device 2 may perform drawing with even higher accuracy.

Additionally, light source output measurement unit 23 may be configured from beam splitter 23a provided on an optical path and photodetector 23b, for example.

<Nail Forming Method>

A nail forming method that uses nail forming device 2 described above will be described with reference to FIG. 5.

First, a user coats the surface of his/her nail 1 on which the nail art is to be applied with photo-curable resin 3, which is a nail material (resin-coating step S1). In the resin-coating step, the entire nail is simply coated, and there is no need to form a drawing pattern by photo-curable resin 3.

Next, a drawing pattern is selected, and control of the radiation position and the radiation time of light is performed by controller 6 according to the drawing pattern and feedback information such as the three-dimensional shape of nail 1 and the level of output, and the photo-curable resin is partially cured at drawing area 3a (curing step S2). Additionally, in the curing step, nail forming device 2 described with reference to FIG. 1 is used, and controller 6 controls at least one of light source 4 and reflection mirror 7 according to the density of the drawing pattern. Control of the radiation time, the level of output of light and the like for nail forming device 2 is as described above, and description here is omitted.

Next, photo-curable resin 3 in non-cured area 3b, which is not cured with light and which is not cured, is removed (removal step S3). A desired drawing pattern may be formed by the series of processes of resin-coating step S1, curing step S2, and removal step S3.

Also, if resin-coating step S1, curing step S2, and removal step S3 described above are repeatedly performed, a three-dimensional drawing pattern having a laminate structure may be formed. Also, by using a gel nail with differently colored layers, a colorful drawing pattern may be formed.

Moreover, since the curing wavelength is different depending on the type of photo-curable resin 3, a plurality of light sources 4 with different wavelengths are desirably provided as light source 4. At the time of control of light sources 4 by controller 6, the control condition is desirably different for each of different waveforms.

Furthermore, in the exemplary embodiment described above, an example is described according to the case in which the nail art is applied on the surface of nail 1, but the same effects may be obtained also when the nail art is applied on an artificial nail by nail forming device 2 of the present exemplary embodiment.

Still further, in the present exemplary embodiment, an example is described according to the case in which a user applies the nail art on his/her own nail 1 by nail forming device 2, but nail forming device 2 may be installed at a nail salon, and a nail technician may use nail forming device 2 of the present exemplary embodiment. If nail forming device 2 of the present exemplary embodiment is used by nail technicians, the drawing accuracy may be prevented from being varied depending on the skill of each nail technician, or the application time may be reduced.
The nail forming device of the present invention may easily form a drawing pattern on nails or artificial nails. It is particularly advantageous in the case of a user forming a drawing pattern on his/her own nails.

5. The nail forming device according to claim 2, further comprising a nail detector for detecting a three-dimensional shape of the nail or the artificial nail, wherein the controller controls at least one of the light source and the optical drawing unit according to first information detected by the nail detector.

6. The nail forming device according to claim 5, further comprising a light source output measurement unit for measuring a level of output of the light source, wherein the controller controls at least one of the light source and the optical drawing unit according to second information measured by the light source output measurement unit.

7. The nail forming device according to claim 1, wherein the light source includes a plurality of light sources with different wavelengths.

8. The nail forming device according to claim 1, wherein the light source is configured to a semiconductor laser, and wherein the optical drawing unit is configured to a reflection mirror.

9. A nail forming method for forming a drawing pattern on a surface of a nail or an artificial nail by using a photo-curable resin, the method comprising:
   coating the surface of the nail or the artificial nail with the photo-curable resin;
   partially curing the photo-curable resin; and
   removing a non-cured part of the photo-curable resin,
   wherein, in the curing, the photo-curable resin is partially cured by using a nail forming device including a light source, an optical drawing unit for partially curing the photo-curable resin by using light emitted by the light source, and a controller for controlling the light source and the optical drawing unit.

10. The nail forming method according to claim 9, wherein the controller controls the light source and the optical drawing unit according to a density of the drawing pattern.

11. The nail forming method according to claim 10, wherein a radiation time of the light that is emitted by the light source on a drawing area where the drawing pattern is to be formed is controlled by the controller, and wherein the radiation time is determined for each section of the drawing area.

12. The nail forming method according to claim 10, wherein a level of output of the light that is emitted by the light source on a drawing area where the drawing pattern is to be formed is controlled by the controller, and wherein the level of output of the light is determined for each section of the drawing area.